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VULNERABILITY OF SELECTED URBAN AREAS IN NORTH VIETNAM

I. Introduction

About 10 percent of the population of North Vietnam is urban. Slightly less than two-thirds of this urban population resides in the two largest cities, Hanoi (1961, estimated population, 650,000) and Haiphong (1961, estimated population, 375,000). The next 4 most populous cities, estimated as of 1961, are Thanh Hoa (80,000), Nam Dinh (70,000), Vinh (55,000), and Dong Hoi (55,000). These six cities and two centers of developing industry, Thai Nguyen (30,000) and Viet Tri (25,000), are the subject of this study (see Figure 1).

Selected target installations in the cities or their environs are located on accompanying 1:50,000 maps (Plates I through VIII), and descriptive data keyed to the installations appear on the map aprons.

Since many of the selected installations are located within relatively heavily built-up areas, inadvertent destruction of civilian residences and/or other nontarget buildings may occur in connection with air strikes. The degree of destruction from fire, whether spread by high explosive bombing or incendiary bombing, is generally related to: (1) the density of the buildings, or their "built-upness," a term used by the US Strategic Bombing Surveys on Japan,* and (2) the combustibility of material used in the construction of the buildings.

II. Density of Buildings

The degree of "built-upness" in various areas of Hanoi and Haiphong is shown in the Built-up Area Density maps on Plates I and II. Similar maps are unavailable for the other six urban areas, but radar-return maps which give some indication of the location and density of buildings have been substituted on Plates III through VIII.

On the Built-Up Area Density maps of Hanoi and Haiphong, the density is described in terms of roof coverage in three categories: (1) densely built-up (over 40 percent roof coverage), (2) moderately built-up (20 percent to 40 percent roof coverage), and (3) sparsely built-up (5 percent to 20 percent roof coverage).

Some concept of the extent of damage which may occur in the different zones of built-upness in Hanoi and Haiphong may be gained by a comparison with information in the US Strategic Bombing Surveys. Figures 2, 3, and 4 are based on detailed measurements in selected Japanese cities. Figure 2 shows the percentages of built-upness and areas occupied in square miles for various functional categories. Figure 3 shows the percentages of damage in different zones of built-upness by functional categories; Figure 4 is a graphic complement of Figure 3. The Japanese experience may be used as a very rough guideline to an estimate of possible damage to the residential areas of Hanoi and Haiphong. Validation and further refinement of the estimate require detailed consideration of any significant differences in construction materials or types of ordnance used. (Figures 5 through 8 allow some visual comparison of dwelling density and building types in Japanese and North Vietnamese cities.)

*A Report on Physical Damage in Japan, The US Strategic Bombing Survey, Physical Damage Division, June 1947.

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III. Combustibility of Building Materials

The US Strategic Bombing Survey after analyzing Japanese building construction concluded that "only a few Japanese buildings were safe from fire and could effectively serve as area fire stops." A comparison of Japanese with Vietnamese construction indicates that the combustibility potential of Vietnamese buildings may be significantly less.

A. Japanese Buildings

The Bombing Survey describes the typical Japanese dwelling as one or two stories high with heavy wood sills and a wood or stone foundation without basement, 1-1/2 feet above ground level (see Figures 9 and 10). Wood frames were 4 by 4 inches and the rafters were often 4 by 6 inches. The roof was usually tile, set on mud-covered 1/2- to 2-inch wood sheathing over wood supports. Ceilings consisted of wide 1/4-inch wood boards loosely suspended on 2- by 2-inch supports. The floors were 1/2-inch boards covered by 2-inch rice-straw "tatami" mats except in hallways where 3/4-inch boards were used. Walls were made of bamboo laths thickly coated on both sides with natural-cement mud, and most exterior sides were weather-protected by a wide, 1/2-inch, unpainted lapboard. Interior partitions were either thin mud-bamboo, window frames with glass or paper, or thin panels of wood.

B. Vietnamese Buildings

Clay of excellent quality for making brick occurs in abundance near most of the urban areas in North Vietnam, and wood is relatively scarce. Brick is therefore probably the most widely used building material. Masonry construction, moreover, is dominant in at least the larger cities.* Because of this fact, it has been generalized that the danger of conflagration in the larger Vietnamese cities is not great.** It may be surmised, however, that the framing beams in the older houses are tinder-dry and would burn readily.

Buildings of masonry walls and tile roofs are most common in the French-built sections, which include administrative and cultural institutions and commercial and residential areas. The residences are typically detached, single-family dwellings situated in separate lots along broad, tree-shaded avenues, a condition which would minimize fire spread. Fire would be more likely to spread among the dwellings in the Chinese quarters of Hanoi and Haiphong which, although generally of masonry, are crowded together.

In contrast to these buildings, the traditional Vietnamese dwelling is a single-family, thatched-roofed structure of bamboo frame covered with plaster or bamboo mats (see Figures 11 and 12). It is highly inflammable. In Hanoi and Haiphong, such buildings are generally limited to small settlements in the outskirts. In the smaller cities, these thatched-roof huts are likely to occur also within the city proper, where they may be intermixed with masonry structures. Shacks made of corrugated iron and wood, as well as junks and sampans which line the canals in the Chinese quarter of Haiphong, are living quarters for thousands of inhabitants; these structures would be highly inflammable (see Figure 13).

* Most of the North Vietnamese urban areas, however, are built on deltaic alluvial soils, which will not support great weight without special engineering. Few buildings exceed 4 or 5 stories in height.

** NIS, North Vietnam, Section 25, Urban Areas, p. 25-2.

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Masonry construction is common in the workers' housing built in recent years in the vicinity of industrial installations such as at Thai Nguyen (see Figure 14); in new apartments such as those on the southern limits of Hanoi (see Figure 15); and in the major new industrial installations,* in permanent army barracks, and in some large warehouses such as the steel-frame concrete warehouses located behind the Haiphong wharves.

IV. Functional Divisions

Vietnamese cities are more or less divided into functional divisions which may help to limit fire spread into residential zones, since selected targets are more likely to be grouped in nonresidential divisions (see Functional Divisions of Built-Up Areas on Plates I through VIII).

The distinct differences between functional divisions are most clear in Haiphong, where canals (which, in themselves, are firebreaks) partially delineate the six distinctive functional areas. The strip along the Cua Cam shoreline comprises the port area, including enterprises directly concerned with port activities. The central part of the city is composed of: (1) the commercial district and (2) the mixed residential and commercial division (the densely populated Chinese quarter) lying east of the bend of the Song (River) Tram Bac. South of the Chinese quarter is an almost exclusively residential division. The eastern and western parts of the city are industrial divisions.

A large number of selected installations are located on the island which is bordered on the south and east by the Song Tram Bac (see Plate II). The main residential divisions are isolated from the island and would not be threatened by fire spread from it.

Hanoi is less clearly divided, although five main functional divisions are present (see Plate I). The north-central section contains the Citadel, a military area. The east-central and northwest sections (the latter being generally west of the Citadel) were developed by the French. Both are chiefly residential, with some mix of governmental and institutional buildings. The northeast and southeast sections are mainly mixed residential-commercial areas, the northeast section, bounded on the north and west by the railroad line, being the oldest and most densely built-up part of the city.

In Hanoi the selected installation most definitively isolated from residential divisions is Installation No. 4, the Ministry of Defense, located in the Citadel.

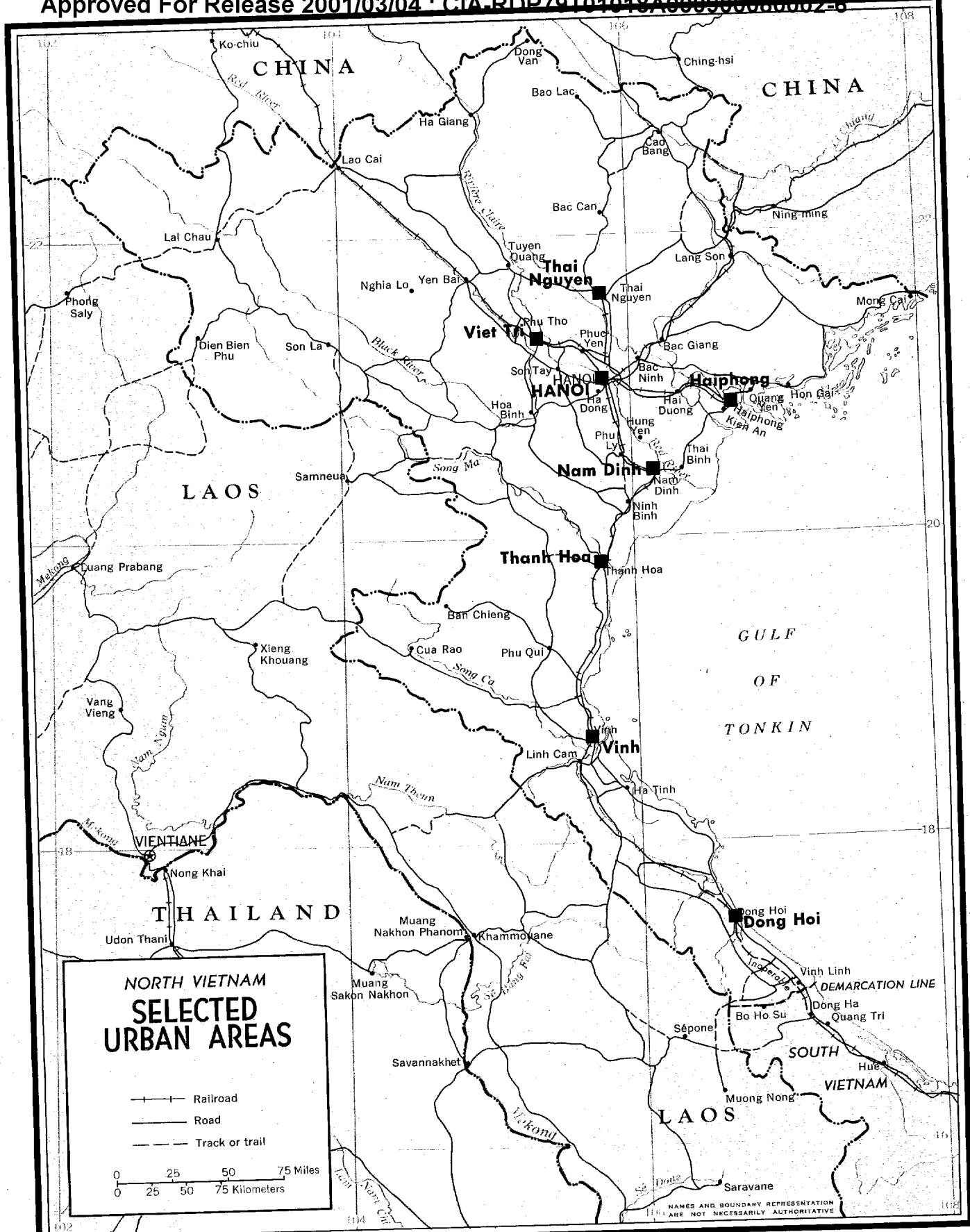
The location of installations with respect to functional divisions in the smaller urban areas can be ascertained by examination of the individual maps on Plates III through VIII.

*An article on Vietnamese architecture in the Chinese-language periodical, Chien-chu Hsueh-pao (Journal of Construction), No. 11, 1963, pp. 24-29, describes the main structure of new North Vietnamese industrial complexes as being made of reinforced concrete, prefabricated or poured on the site. The roof is generally flat, of reinforced concrete, and in some cases insulated against heat. Secondary buildings in the industrial complexes may be of brick and wood construction and generally have tile roofs.

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Figure 1

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	Residen- tial ¹		Residen- tial ²		Residen- tial ³		Mixed resi- dential and industrial	
	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area
Akashi ⁴	.23	.85			.11			
Amagasaki	43.0	.91	29.8	1.90	16.5	.30	28.8	.35
Kawasaki	45.0	2.26	31.8	3.69	16.7	5.80	31.0	.37
Kobe	49.2	5.79	30.3	3.34	16.3	6.81	50.0	.54
Nagasaki	44.0	.75	30.0	1.43	12.0	.98	33.0	.06
Nagoya	39.4	4.98	31.1	12.78	17.4	12.65	30.4	1.97
Nishinomiya	49.2	.47	30.3	5.32	16.3	3.99	50.0	1.11
Osaka	43.0	20.88	29.8	17.94	16.5	5.85	28.8	3.92
Tokyo	46.0	22.50	30.9	53.84	16.6	63.89	30.3	7.39
Yokohama	44.5	2.02	31.2	6.50	11.0	6.14	32.5	.46
Unweighted average	45.0		30.6		15.5		35.0	
	Manufactur- ing		Trans- portation		Storage		Total built-up area	
	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area	Percentage built-up	Area
Akashi ⁴								
Amagasaki	37.7	2.47	9.0	.05	37.8	.17	6.15	
Kawasaki	43.4	5.19	14.9	.35	31.5	.59	18.25	
Kobe	44.9	1.55	9.3	.70	53.6	.69	19.42	
Nagasaki	46.0	.42	9.0	.04	29.0	.15	3.83	
Nagoya	40.0	6.49	8.3	.22	42.6	.04	39.73	
Nishinomiya	44.0	1.05	9.3	.06	53.6	.03	12.03	
Osaka	37.7	10.43	9.0	.78	37.8	3.11	62.91	
Tokyo	37.9	12.45	29.7	1.67	26.2	2.34	164.08	
Yokohama	33.6	1.54	27.7	.20	27.5	.92	17.78	
Unweighted average	40.6		14.0		37.6			

¹ Residential - Densely built up (10 percent and over).² Residential - Moderately built up (20 to 40 percent).³ Residential - Sparsely built up (5 to 20 percent).⁴ Complete data not available.

Figure 2. Percentages of built-upness and areas occupied in square miles for certain Japanese cities.

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City	Residential ¹	Residential ²	Residential ³	Manufacturing and residential	Manufacturing	Transportation	Storage
Akashi	92	37	33				
Atmagasaki	29	11	0	39	12	0	0
Aomori	95	95	39				
Hachioji	100	90	19				
Kawasaki	79	51	9	69	19	12	33
Kobe	67	39	21	23	40	38	32
Nagoya	75	29	10	49	32	9	19
Osaka	53	8	8	20	18	8	18
Tokyo	76	40	40	33	17	10	21
Ube	56	42	4				
Yokohama	85	66	21	86	19	33	33
Unweighted average	73	46	23.5	45.5	22.5	15.5	22

¹ Residential - Densely built up (10 percent and over).
² Residential - Moderately built up (20 to 40 percent).
³ Residential - Sparsely built up (5 to 20 percent).

Figure 3. Percentages of damage in different zones of built-upness.

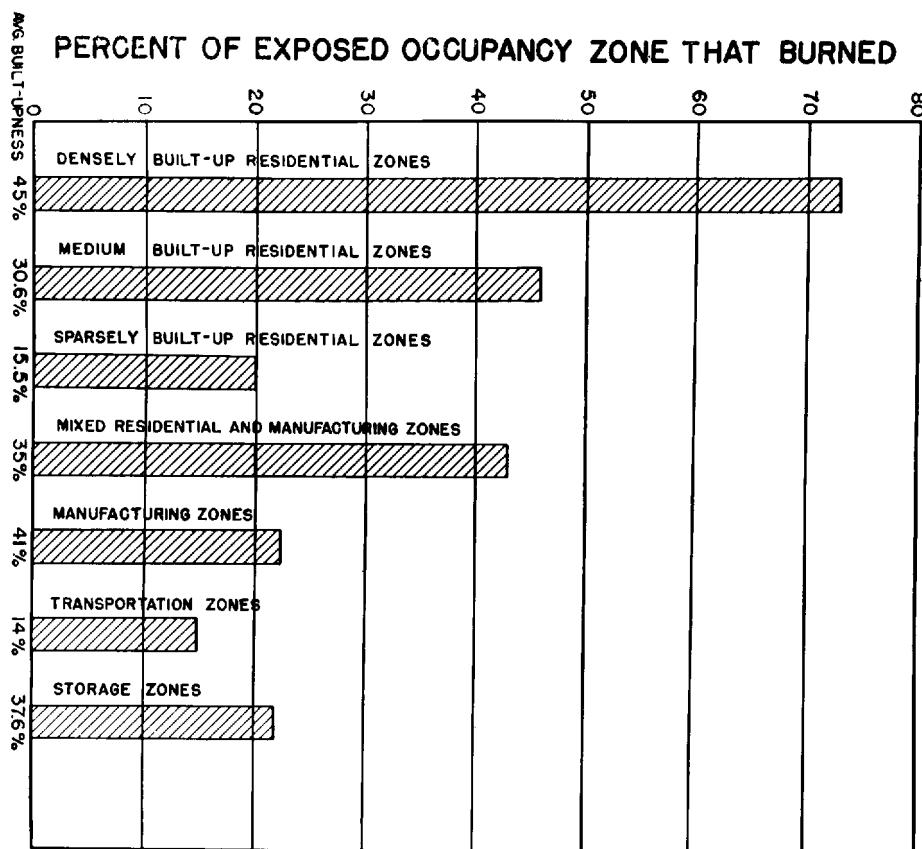


Figure 4. Graphically illustrates the data in Figures 2 and 3, showing the average percent of fire damage in 7 different functional zones.



Figure 5. Built-up area in Nagoya, Japan, showing fire resistant buildings interspersed among areas formerly occupied by combustible buildings.



Figure 6. Densely built-up Chinese quarter of Hanoi. Buildings are of masonry construction.

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Figure 7. Typical densely built-up area of small Japanese city.



Figure 8. A view of Nam Dinh showing density and construction of buildings.

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Figure 9. Japan. Combination one- and two-story mercantile structures with dwelling occupancy on second floor. Unpainted wood siding usually covered mud-filled walls.



Figure 10. Japan. Typical dwelling in smaller Japanese city.



Figure 11. Vietnamese dwellings near Thanh Hoa.
The sides are of palm or bamboo mats and the roof is thatched. Such houses are generally on the outskirts of the larger cities but may be intermixed with masonry structures in the smaller urban centers.



Figure 12. Shows framework of typical thatched-roof Vietnamese dwelling in Vinh area. According to Soviet source of picture, house was being rebuilt after destruction by U.S. bombing.



Figure 13. The Chinese quarter of Haiphong borders the Song (River) Tram Bac. Many of the junks and sampans serve as homes.

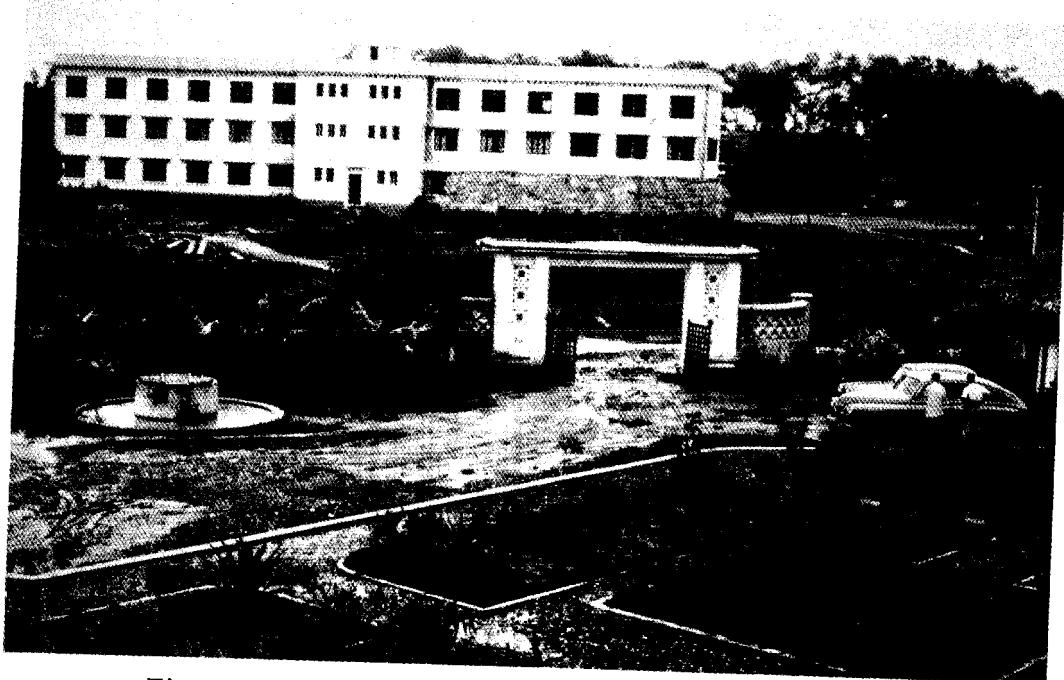


Figure 14. Thai Nguyen. Cadre workers' apartments, of masonry construction.

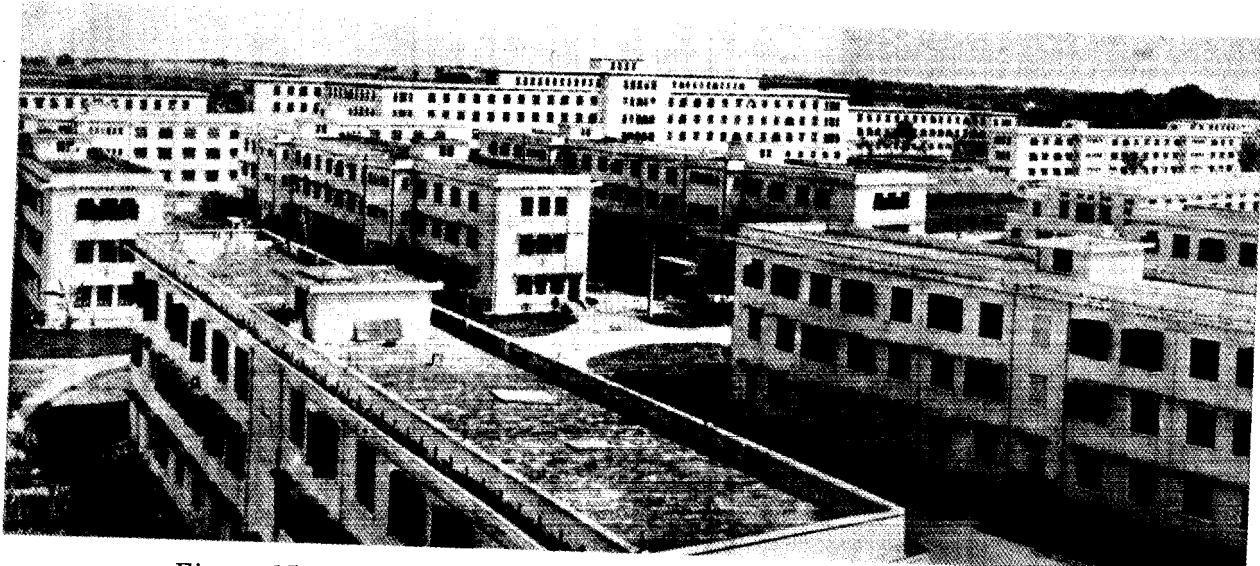


Figure 15. New apartments, of masonry construction, on the southern outskirts of Hanoi.

PLATE IV

NAM DINH - SELECTED INSTALLATIONS

Map Scale 1:50,000

Installation

1. Railroad Yard. Army Barracks and Storage Depot, West. Troop capacity, 950 men in 20 barracks. Storage capacity, 27,500 square feet in 11 buildings. 16 buildings.

2. Army Barracks, Southwest. Railroad Yard. Serves the industrial and commercial center of Nam Dinh. Facility includes 2 freight sheds and passenger station.

3. Petroleum Products Storage. Industrial installations in lower Tonkin Delta. 11 tanks with capacity of 2,183,000 gallons. Installation destroyed.

4. Thermal Power Plant. Capacity 7,500 kilowatts, comprising over 1 percent of national capacity. As of 6 August 1965, all target elements either destroyed or damaged. Plant probably inactive.

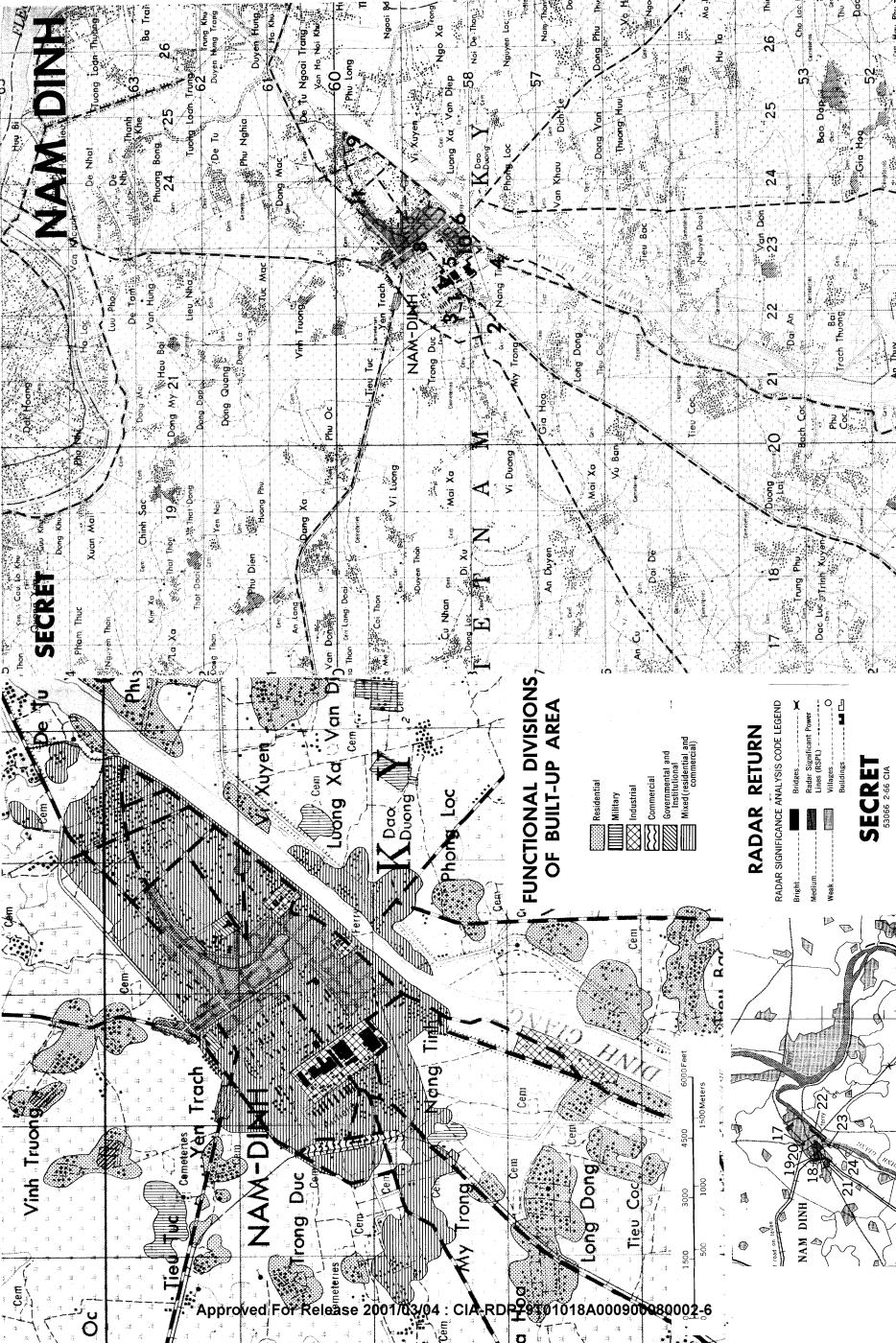
5. Minor river port serves only immediate area of Nam Dinh. 25 storage and support buildings.

6. Port Facilities. 7 multi-storyed buildings produce cotton, rayon, and silk textiles. As of 6 August 1965, 3 buildings moderately damaged.

7. Textile Plant and support buildings. Waterworks. Waterworks. Distillery. Communication Service.

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PLATE V

VINH - SELECTED INSTALLATIONS

Map Scale 1:50,000

Installation

1. Vinh Army Barracks Central Northeast
Capacity 3,900 men. 64 buildings. As of 18 September 1965, a large number of the buildings were destroyed or severely damaged.

2. Telegraph Office.

3. Security Station.

4. Railroad Equipment Reconstruction Shops.

5. Vehicle Repair Plant

6. Military College

7. Vinh Army Barracks and Supply Depot East
Capacity 9,000 men. 279 buildings. Most significant mid-67 buildings were destroyed, 10 severely damaged and 59 damaged.

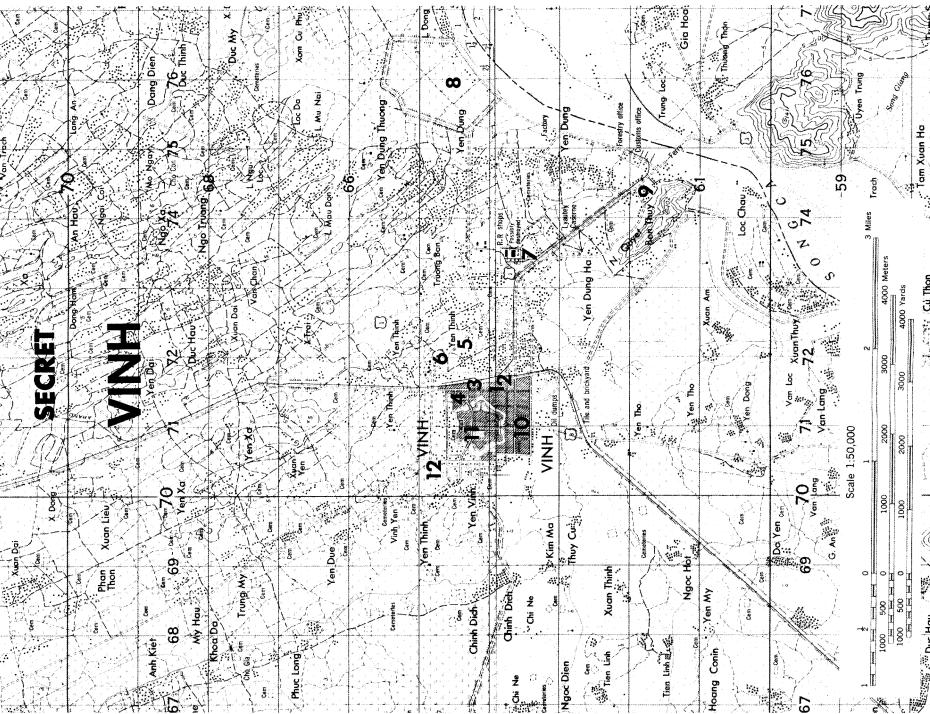
8. Vinh Petroleum Products Storage
Installation may be abandoned or serve only local users.

9. Ben Thuy Thermal Power Plant
Provides power for the Vinh military/industrial complex, Ben Thuy harbor, and the irrigation pumping stations serving the 50 portion of Nghe An province. As of 4 June 1965, the transformer house was destroyed and the boiler house severely damaged.

10. Open and Covered Storage Area.

11. Vinh Army Barracks Citadel
Capacity 1,500 men. 30 buildings.

12. Vinh Army Barracks Northwest
Capacity 1,800 men. 158 buildings. As of 24 September 1965, 75 buildings were destroyed, 30 severely damaged, and 38 destroyed.



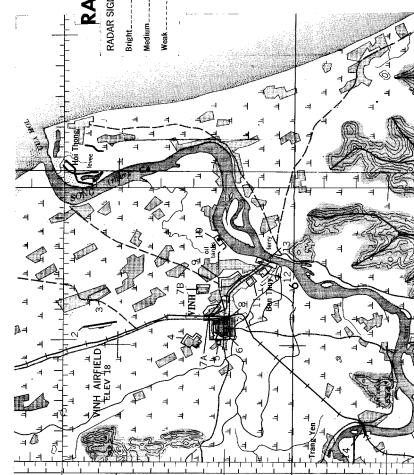
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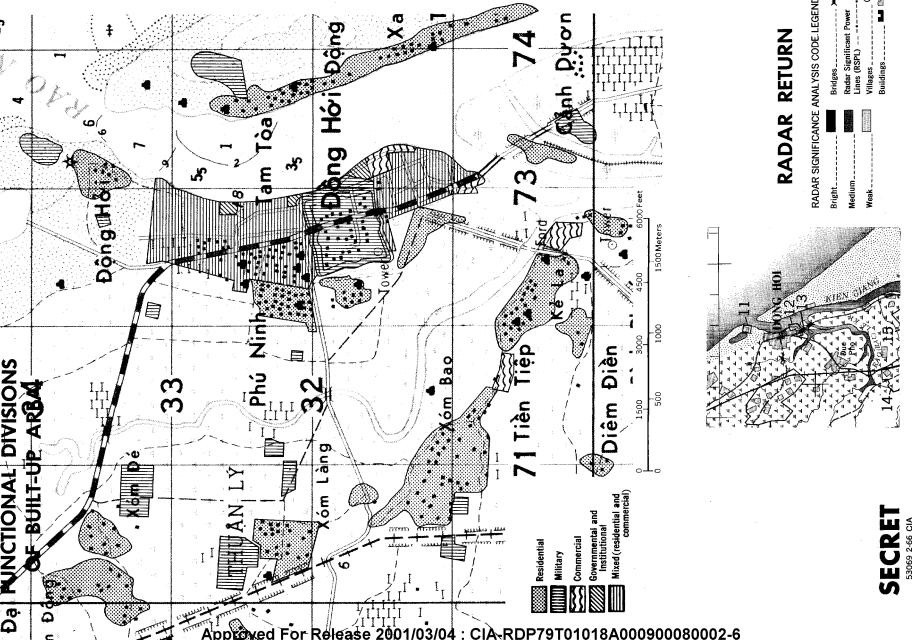
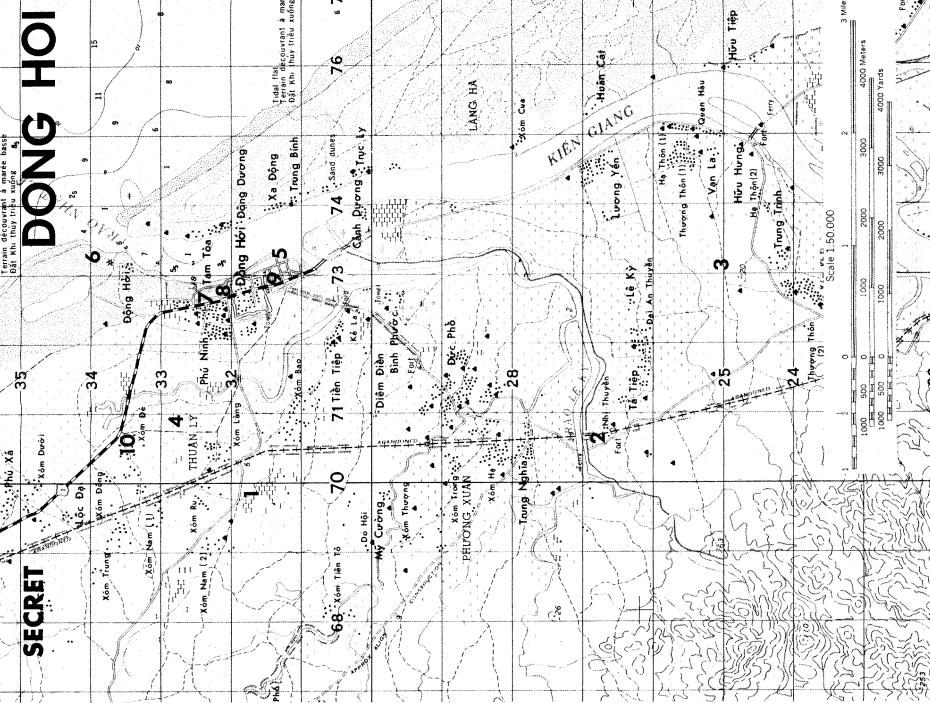
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